STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX I

COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1989

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AIR RESOURCES BOARD

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VOLUME II

STANDARD OPERATING PROCEDURES
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APPENDIX I.1

STATION OPERATOR'S PROCEDURES
FOR THE
COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1989

I.1.0 GENERAL INFORMATION

The Columbia Scientific Industries (CSI) Precision Calibrator System is used to assess how precisely sulfur dioxide (SO_2)* and ozone (O_3) analyzers measure ambient air quality monitoring data. The calibrator system is capable of providing zero air and preselected concentrations of SO_2 and/or O_3. The precision checks are performed by introducing known concentrations of calibration gases into the sampling manifold. The O_3 and SO_2 analyzer inlets are connected to the sampling manifold and corresponding analyzer responses are recorded on the strip chart. The true concentrations are compared with the analyzer responses, and a statistical analysis of the recorded data is performed.

This appendix has been developed to supplement the manufacturer's manual with instructions for installing, servicing, and troubleshooting the calibrator. A detailed discussion of the CSI Precision Calibrator is contained in the manufacturer's operating and service manuals.

I.1.0.1 SYSTEM DESCRIPTION - The CSI Precision Calibrator System consists of a Model 1795 calibration air supply chassis and a Model 1790 programmable gas calibration chassis. The Model 1795 is capable of providing up to 10 SLPM of high purity zero air. The Model 1790 contains two constant temperature ovens: one housing two permeation tube holders and the other housing the O_3 generator.

The CSI user can select either a high or a low rate permeation tube and generate two different SO_2 concentrations. Different ozone concentrations can be generated by adjusting the drive current to the ozone generator.

The precision calibrator system has four operating modes (also, see Programming):

1. Timer Mode - This mode has a 6-step automatic program initiated every 24 hours by an internal timer. A 4 decade thumbwheel switch is used to set the timer program start time from 0000 to 2359. Depressing the "Timer" push button switch on the main panel initiates the calibration sequence. The calibration sequence is determined by the timer program switches on the recessed control panel (RCP).

2. Precision mode - This mode has a 6-step automatic program and is manually initiated by the depression of the "Prec" push button switch on the main panel. The precision calibration sequence is determined by the precision program switches on the RCP.

* The CSI can also use other permeation devices (e.g. NO_2), but this manual will address only SO_2 -- Your monitoring will dictate what pollutant analyzer you wish to test.

3. Manual mode - This mode allows the operator to control dilution zero air flow and ozone concentrations to produce desired concentrations of SO_2 and O_3. The user can perform multipoint linearity checks and adjust the preset parameters on the RCP employed in the timer and precision modes. This mode is initiated by depression of the "Manual" push button switch on the main panel and manually selecting the zero air, O_3, or SO_2 function on the "Manual Select".

4. Standby mode - The depression of the "Standby" push button switch terminates the manual mode. The standby mode's yellow LED light indicates that the calibrator system is ready to supply calibration gas in the timer, precision, or manual operating modes. No operational mode may be initiated unless the calibrator system is first in the standby mode.

I.1.0.2 PHYSICAL DESCRIPTION - The calibrator system consists of two separate chassis; a CSI 1790 electronics chassis (19" wide x 7" high x 24" deep), containing the gas calibration controls circuitry, solenoid valves, mass flow controller, precision regulators, permeation tubes oven, ozone generator oven, etc.; and a CSI 1795 pneumatics chassis (16-1/2" wide x 10-1/2" high x 25" deep), containing a system pump, air purification system, accumulator, etc. The two chassis are interconnected by an umbilical cable and gas lines (see Figure I.1.1.1). Two drier tubes containing silica gel are used to dry the purge and the carrier air flows. Figures I.1.0.1 and I.1.0.2 depict the front and the rear views of the calibrator.

I.1.0.3 PROGRAMMING TIMER AND PRECISION MODES - The program step sequence, calibration gas, concentrations, and step times listed on the next page are applicable to both timer and precision modes. The dilution air flow rate is set at 5 SLPM nominal. Actual concentrations and flow rates may differ from those given below due to variations in mass flow controller and ozone generator calibrations. Step times are usually set at 20 minute intervals but may be varied depending upon the need of each particular station (see Section I.1.3.1). The daily checks (Timer Program) shall be selected so as not to interrupt daily maximum hourly averages. The time should be set to minimize hourly data loss (start checks 10 minutes before the hour).

Step Sequence: timer and Precision Modes

Step Number	Calibration Gas	Concentration, ppm	Step Time, Minutes
1	Zero	—	20 ± 5
2	High O_3	.50 ± .10	20 ± 5
3	Low O_3	.09 ± .01	20 ± 5
4	Zero	---	20 ± 5
5	High SO_2	.40 ± .05	20 ± 5
6	Low SO_2	.09 ± .01	20 ± 5

Two, seven-position on/off dip switches located on the RCP (see Figure I.1.0.1) are used to select the steps for the timer and precision calibration modes. Off position of a program switch skips that step function. The last position of the switch is always skipped.

To program the calibrator in the timer or precision modes for both SO_2 and O_3, set the position of on/off dip switches as follows:

Step Number	Calibration Gas	Timer Mode Dip Switch Position	Precision Mode Dip Switch Position
1	Zero A	on	on
2	High O_3	on	off
3	Low O_3	off	on
4	Zero B	off	off
5	High SO_2	on	off
6	Low SO_2	off	on

If either O_3 or SO_2 are not required, turn corresponding switches to the off position.

I.1.0.4 PROGRAMMING MANUAL MODE - The manual mode allows the user to the dilution air flow and selecting either the high or low SO_2 permeation rate by depressing the appropriate switch. Dilution air flow is controlled by a ten turn potentiometer marked "Flow" on the front panel of CSI 1790. This potentiometer regulates total flow in manual mode with the "Manual Control" switch on the RCP set to "variable". O_3 multipoint linearity checks are performed by adjusting the drive current to the O_3 generator at a fixed air flow rate. Then turn the potentiometer marked "Ozone" on the front panel of CSI 1790, which is used to regulate the O_3 concentrations with the "Manual Control" switch on RCP set to "Variable" and either high O_3 or low O_3 selected on the "Manual Select" switch. The "Manual Select" switches are operable only in "Manual" mode.

NOTE: When "Manual Select" push button switches are depressed, the corresponding indicator illuminates, the zero air system is started and the output valve is opened. When the "Manual" mode is selected but not "Manual Select" function has been depressed, no output action occurs, but initiation of a program sequence is stopped. When the "Manual" mode is terminated, the zero air system shuts down and the output valve is closed.

I.1.0.5 PROGRAM ADVANCE - The Program Advance, spring-loaded slide switch is located on the RCP. Depressing the switch terminates the current step in a programmed sequence at approximately one step per second. This function may be used to rapidly correct operation of a sequence or to terminate a sequence and return to "Standby".

I.1.0.6 CAUTIONS

1. To avoid unwanted calibration sequences, changes to the setting of the calibration time thumbwheel switch should be done only in "Manual" mode.

2. The internal DC power switch on the COUNTER-TIMER PCB should be turned off and power cord disconnected before removing components for maintenance.

3. The U.V. lamp utilizes high voltage. Use normal high voltage precautions when working on the calibrator system. Do not work on the calibrator with the power on unless the test absolutely requires it, and then only after removing your watch, rings, etc.

4. The ozone generator contains an ultraviolet lamp, which emits U.V. light that can cause burns to the eyes. Use U.V. safety glasses while working on the ozone generator.

5. Operate the calibrator with the covers on each chassis.

6. Bleed pressure from dryer tubes prior to replacing the silica gel.

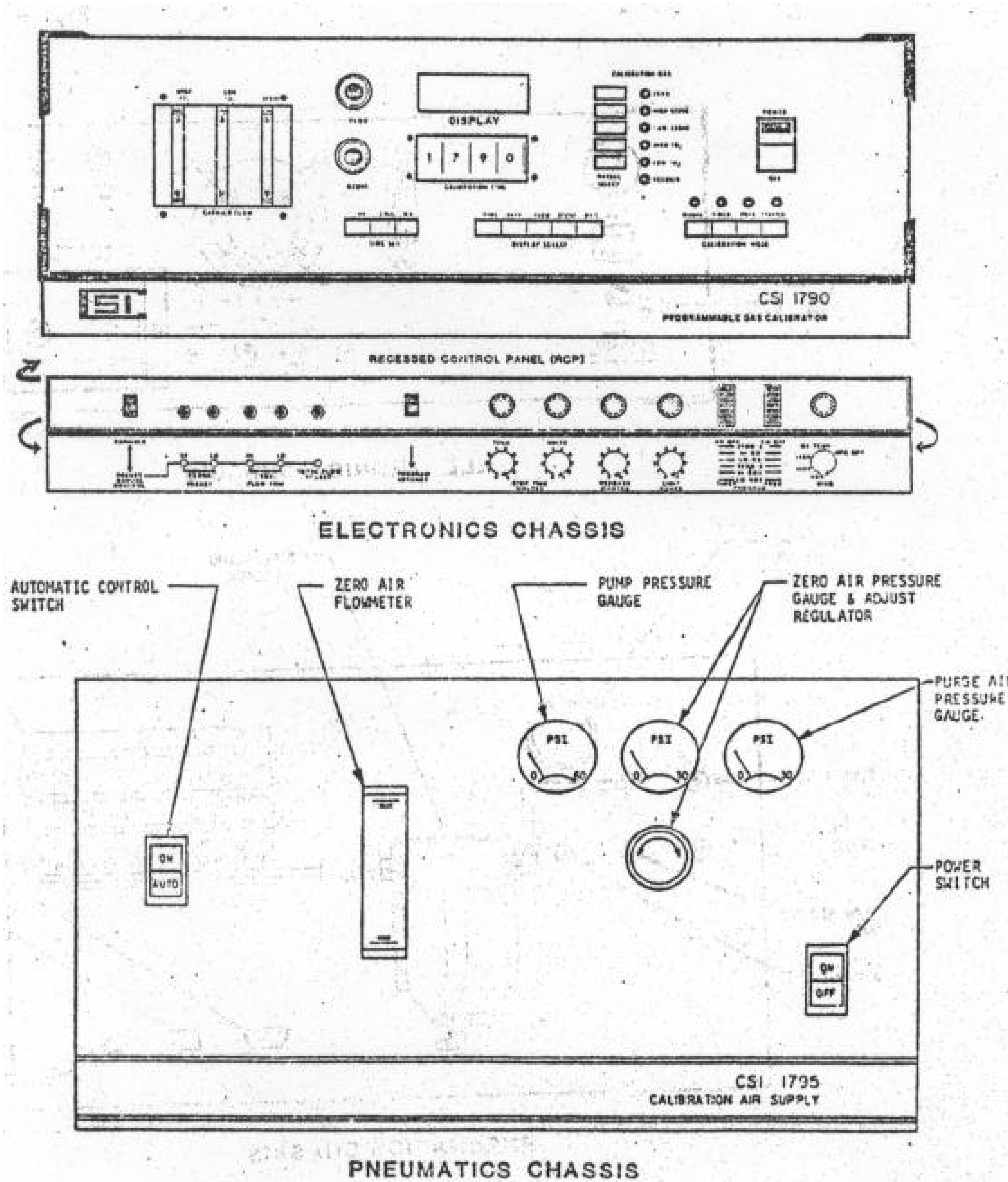

Figure I.1.0.1
Front View of Calibrator

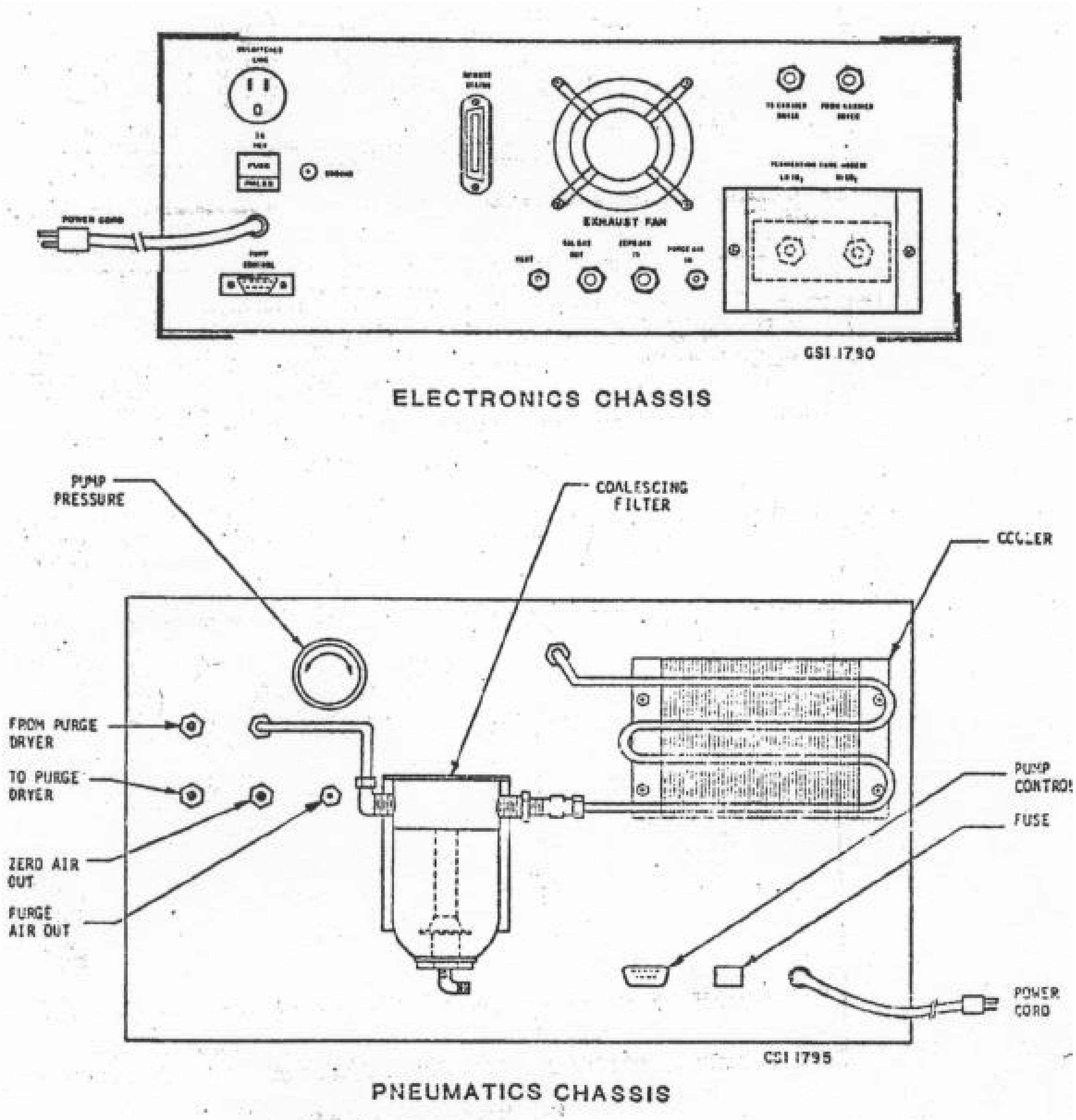

Figure I.1.0.2
Rear View of Calibrator

I.1.1 INSTALLATION PROCEDURE

I.1.1.1 PHYSICAL INSPECTION - Unpack the calibrator and check for external shipping damage. Remove the covers and check for loose circuit boards, relays, solenoid valves, etc. Check fittings for tightness and then reinstall covers.

I.1.1.2 INITIAL SET-UP (See Figure I.1.1.1)

1. Rack mount the calibrator in close proximity to the end of the sampling manifold and, when applicable, to the Monitor Labs Model 9300 or 9400. Where a rack is not available, set the chassis side by side on a flat, level table.

2. Remove plugs from the rear panel bulkhead ports and the coalescing filter drain.

3. Connect the "vent" output port at the rear of the electronics chassis to a Teflon vent line to exhaust spent gases away from the sampling probe.

4. Connect the "Cal Gas Out" output at the rear of the electronics chassis to a sampling manifold (see Section I.1.1.4).

5. Connect "Zero Air Out" and "Purge Air Out" ports at the rear of pneumatics chassis to "Zero Air In" and "Purge Air In" ports, respectively, at the rear of the electronics chassis via Teflon tubing with brass fittings.

6. Fill one of the Wilkerson drier tubes with dry indicating silica gel. Connect the "To Carrier Dryer" and "From Carrier Dryer" ports at the rear of electronics chassis to the drier tube's connector fittings, via Teflon tubing with brass fittings.

7. Fill the other Wilkerson drier tube with dry indicating silica gel. Connect the ports labeled "To Purge Air Dryer" and "From Purge Air Dryer" at the rear of pneumatics chassis to the drier tube's connector fittings, via Teflon tubing with brass fittings.

8. Connect a 1/8" tube from the coalescing filter drain fitting to an appropriate water drain or container.

9. Connect the 9 pin electrical remote control (umbilical) cable from the electronics chassis (CSI 1790) pump control connector to the pneumatics chassis (CSI 1795) pump control connector. Lock the connectors in place with the "hairpin" spring retainers. Connect the power cords from the electronics and the pneumatics chassis to the AC power outlet.

10. Depress the "Power Switch" on CSI 1790 to the "On" position.

11. Check and adjust various pressures on CSI 1795 as follows:

    a. Set the "Zero Air" switch to the "Auto" position and the "Power" switch to the "On" position. "Power" switch indicator red light should light and the pump and fan should begin to operate.

    b. The pump pressure gauge reading should rise to the preset value of 55 psi ± 5 psi on the front panel. This pressure can be adjusted by the pump pressure regulator on the rear of the CSI 1795 as necessary. To adjust, pull out the lock ring concentric with pump pressure regulator knob. Turn knob clockwise to increase pump pressure, counterclockwise to decrease pump pressure.

    c. The zero air pressure gauge reading on the front panel should rise to 20 psi ± 5 psi with no flow indicated for zero air. If necessary, this pressure can be adjusted by pulling out the lock ring concentric with the zero air pressure regulator knob. Turn the knob clockwise to increase zero air pressure and counterclockwise to decrease the zero air pressure. Push in the lock ring after adjustment.

       NOTE: The zero air pressure regulator is located under the zero air pressure gauge.

    d. The purge air pressure gauge reading should rise slowly to its preset cut-off point of 50 ± 5 psi. The pump should stop at this point (after approximately 4 minutes). Then allow the purge air pressure to fall to its preset cut-on point of 5 psi. The pump should start at this point (after approximately 90 minutes). The adjustments to preset cut-off/cut-on points can be made by turning the appropriate screw on the pump standby pressure switch located on the inner back wall of the CSI 1795.

    e. Check if the pressure relief valve in the CSI 1795 chassis is set at 60 psi. Allow the pump pressure to rise to 60 psi. The pressure relief valve should come "on" to limit maximum pump pressure to less than 60 psi. Adjustments can be made by turning the Allen nut at the base of the pressure relief valve with an Allen wrench.

12. Check out the Remote Control function as follows:

    a. Disconnect the zero air output line on the rear of the CSI 1795. Depress the "Zero Air" switch to the "on" position. The pump should start, and the zero air flowmeter on the front panel should read between 10 and 15 liters per minute at zero psi indicated pressure. The pre-ozonator lamp should be operating.

    b. Depress the "Zero Air" switch to "Auto". Zero air generator will stop. Select "Manual" mode and zero calibration gas on CSI 1790. Remote command from the CSI 1790 should start zero air generation. Select "Standby" mode on the CSI 1790. Zero air generator will stop. Reconnect the zero air output line on the rear of CSI 1795.

13. Leak check the CSI 1790 as described below:

    a. Establish Zero Flow Baseline - Disconnect the zero air input line on the rear of CSI 1790 and cap the fitting. Select "Manual" mode and press "flow" push button on the "Display Select". Allow the flow reading to stabilize to $\pm$ 2 least significant digits and record. This reading is the mass flow controller output with zero air flow and is the Zero Flow Baseline for air flow through the CSI 1790.

    b. Dynamic Leak Check - Cap the CAL GAS OUT and VENT ports on the rear of CSI 1790. Remove cap and reconnect the zero air input line on the rear of CSI 1790. Select "Standby" mode and set zero air pressure to 20 psi. The display reading should equal to zero flow baseline reading. All three rotometer balls on the Carrier Flow assembly should read zero. Any flow changes are due to the leaks in the main air flow system or the Carrier air flow path.

    c. Leak Check Outlet Solenoid Valve - Remove cap from the CAL GAS OUT port on the rear of the CSI 1790. The air flow should remain at zero flow baseline. Any flow changes indicate a leaky outlet valve. Cap CAL GAS OUT port. Select "Manual" mode. The air flow should not change from the zero flow baseline.

    d. Leak Check Ozonator, Associated Solenoid Valves, Fittings and Lines - Depress "High Ozone" push button. The ozone carrier ball on the Carrier Flow assembly should read zero. The air flow on "Display Select" should stabilize to zero flow baseline reading.

e. Leak Check High SO_2 Permeation Oven Chamber, Associated Valves, Fittings and Lines - Depress "High SO2" push button. The High SO_2 carrier ball on the Carrier Flow assembly should read zero. The air flow on "Display Select" should stabilize to zero flow baseline reading.

f. Leak Check Low SO_2 Permeation Oven Chamber, Associated Valves, Fittings and Lines - Depress "Low SO2" push button. The Low SO_2 carrier ball on the Carrier Flow assembly should read zero. The air flow on "Display Select" should stabilize to zero flow baseline reading.

g. If the CSI 1790 contains leaks, apply a leak detector solution to the fittings and tubing until bubbles or foam are seen, which indicates the location of the leak. Tighten leaky fitting within the flow path and recheck for leaks. If a leak is still found, try to isolate the leak by bypassing the appropriate solenoid valve one by one in the flow path. Tighten the fittings and replace the leaky tubing or solenoid valve as needed.

14. Perform Mass Flow Controller, Ozone Generator, and Permeation Oven Calibrations (refer to Section I.3.2 for details).

I.1.1.3 THE 24-HOUR TIMER - The 24-hour timer is located in the electronics chassis. The timer activates the calibrator timer program. Upon installation, set the timer to Pacific Standard Time (PST), and set the desired starting time of the timer program as outlined below.

1. Set Time of Day - Three momentary push switches above "Time Set" on front of the electronics chassis are used to set the internal 24-hour time of day clock. Depressing "Min", "10 Min", or "Hrs" causes the minutes units decade, tens of minutes decade, or hours to advance at approximately one digit per second. Rollover to the next decade is stopped when a "Time Set" button is depressed.

2. Set Starting Time - A four decade thumbwheel switch above "Calibration Time" is used to set the time of day at which a "Timer" sequence occurs. Stops are installed to limit the range of settings from 0000 to 2359. Changes in the starting time setting should be done in the "Manual" mode.

I.1.1.4 MANIFOLD CONNECTION

1. Connect the calibrator outlet port at the rear of the electronics chassis (CSI 1790) to the sample manifold inlet farthest from the end of the probe inlet. Use Teflon tubing and fitting at the manifold connection and stainless steel fitting at the electronics chassis (CSI 1790).

I.1.1.5 MONITOR LABS, MODEL 9400, DATA LOGGER CONNECTION

1. General Information - The Monitor Labs, Model 9400, Telemetry System Data Logger will scan the analog output voltage of the air quality and meteorological instrumentation and transmit that data, via telephone lines, to headquarters for processing. When the CSI Precision Calibrator is in a calibrate mode, the data being transmitted for processing must be flagged so data generated during calibration can be identified and not be computed into the valid hourly average. An interface cable from the CSI calibrator to the Monitor Labs, Model 9400, Data Logger must be installed to achieve this flagging function. This cable can be obtained from the Air Quality Monitoring Support Section in Sacramento.

2. Installation - The CSI Precision Calibrator is connected to the Monitor Labs, Model 9400, Data Logger through interface cable #CB- 6. A wiring diagram is shown in Figure I.1.1.2 and a cable diagram is shown in Figure I.1.1.3. The plug marked "PI-CCI-940217" is connected to the Contact Closure Input (CCI) card at the rear of the Model 9400 Data Logger. The CCI card number is 940B0217.

3. Check Out - After a Data Logger is connected to the calibrator, contact the Instrumentation and Standards Laboratory (916) 323-5926 in Sacramento. They will check the flagging function from the telemetry central and verify that correct analyzer status is being transmitted.

I.1.1.6 MONITOR LABS, MODEL 9300, DATA LOGGER CONNECTION

1. General Information - The Monitor Labs, Model 9300, Data Logger and the Tektronix, Model 4293, Digital Cartridge Tape Recorder may be used at air quality monitoring stations to scan, average, and record ambient air quality and calibration data. The data is recorded on magnetic tape which can be transmitted by modem or mailed to PTSD headquarters in Sacramento for analysis and evaluation.

When the CSI calibrator system is operated in conjunction with a Monitor Labs, Model 9300, Data Logger, an interface cable must be installed between the two units so that calibration data can be flagged when in a calibrate mode. The cable can be obtained from the Instrumentation and Standards Laboratory in Sacramento.

Installation - The CSI Precision Calibrator System is connected to the Monitor Labs, Model 9300, Data Logger through interface cable #CB-5. A wiring diagram is shown in Figure I.1.1.4 and a cable diagram is shown in Figure I.1.1.3. The interface cable has one plug on each end. The plug marked "CSI" is connected to the receptacle on the rear of the electronics chassis of the calibrator marked "Remote Status". The plug marked "J6" is connected to J6 on the rear of the Model 9300 Data Logger. Observe proper orientation of the interface connector with "J6" on the 9300. (It can be installed backwards.) When facing the rear of the Model 9300, J6 is to the left of J7 and below J1.

Check Out - After the interface cable has been installed, initiate separate zero and span calibration modes from the calibrator. With the calibrator in different calibration modes, set the data logger to scan and print out the data. Check the printed tape for the proper flags. When an analyzer is being spanned or zeroed, "S" or "Z" will appear adjacent to the data printout, respectively.

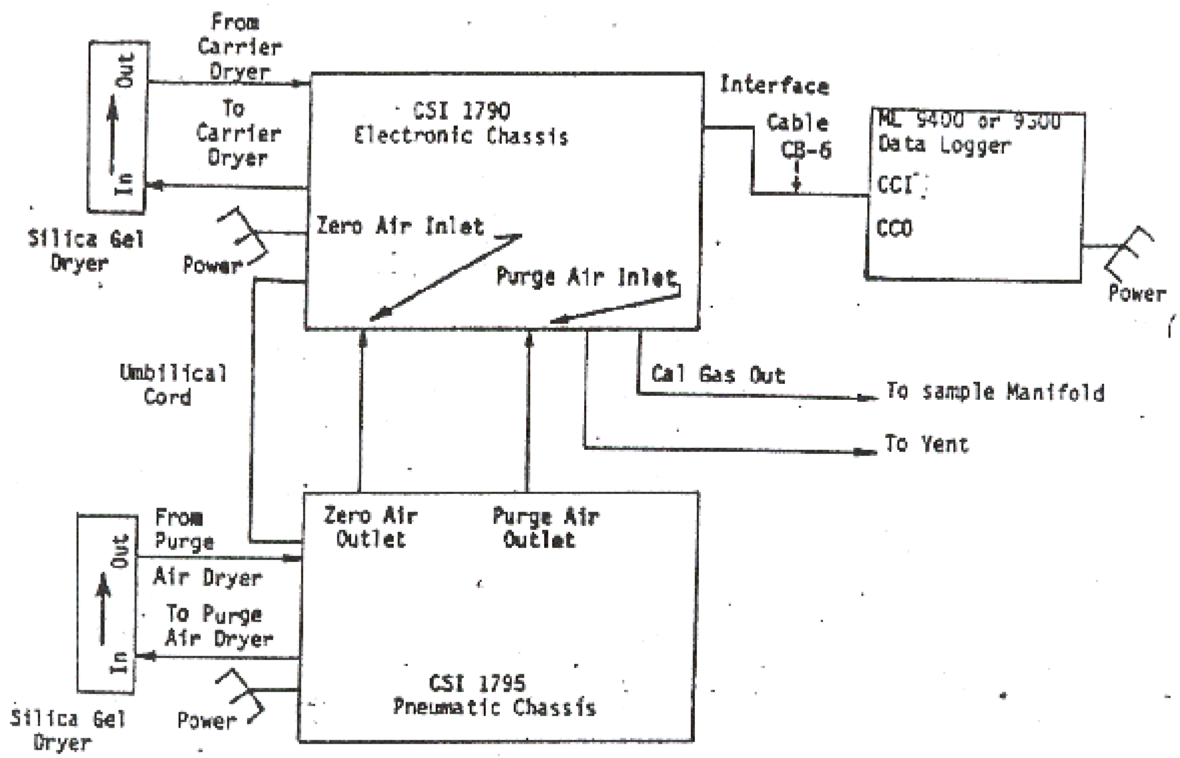

Figure I.1.1.1
Diagram of CSI Precision Calibrator System

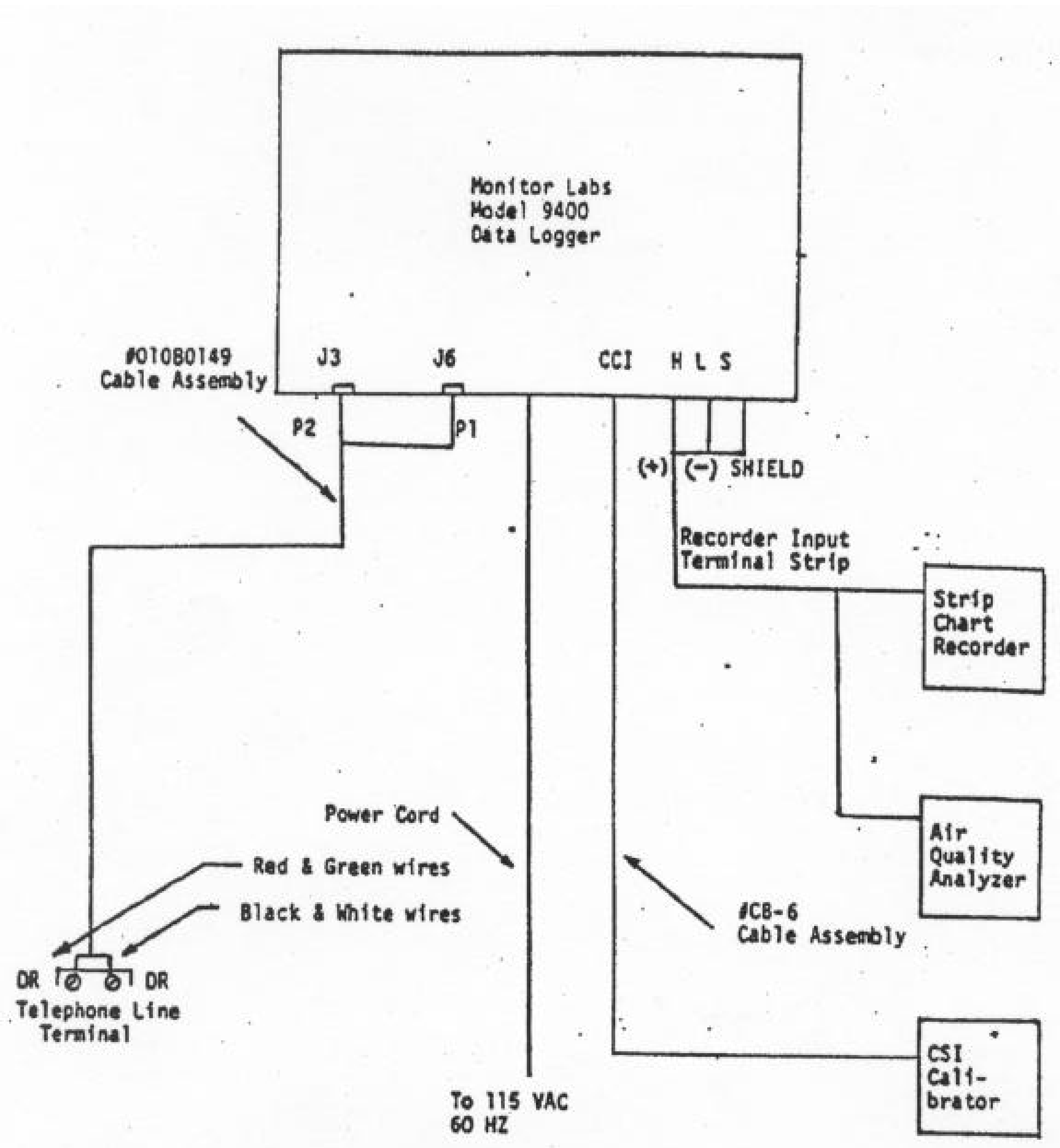

Figure I.1.1.2
Monitor Labs Model 9400 Telemetry System Data Logger Wiring System

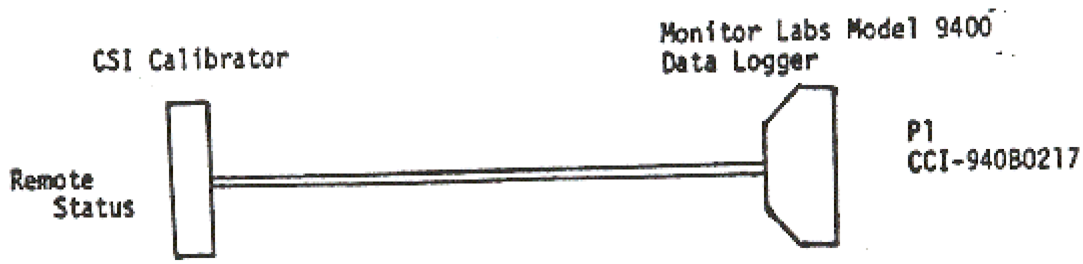

Figure I 1.1.3
CSI Calibrator Interconnecting Cable

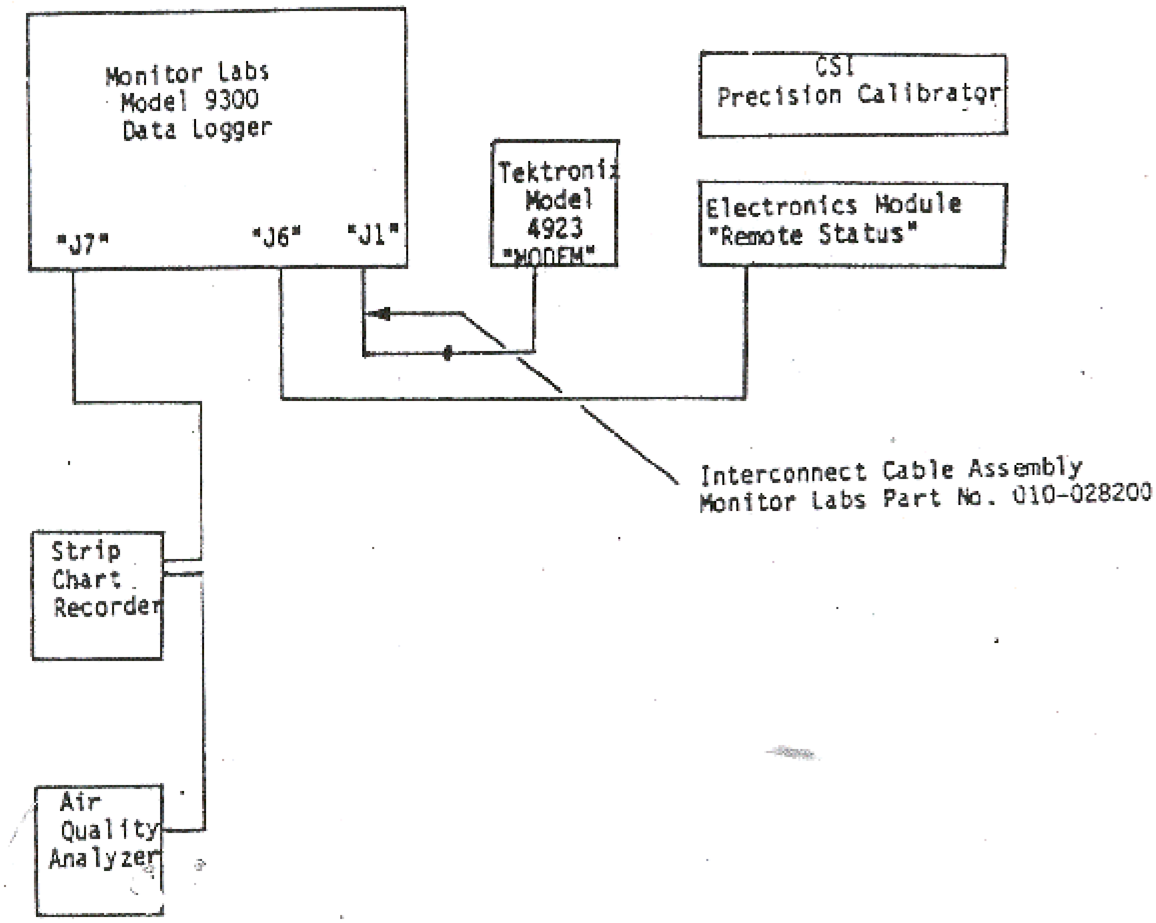

Figure I.1.1.4
Monitor Labs 9300 Data Logger/Tektronix 4923 Tape Recorder/ CSI Precision Calibrator
Interconnection Wiring Diagram

I.1.2 ROUTINE SERVICE CHECKS

I.1.2.1 GENERAL INFORMATION - Perform the following checks at the intervals specified in the service schedule (Table I.1.2.1). Checks may be performed more frequently, but should be performed at least at the prescribed intervals.

NOTE: As experience with the calibrator increases, please forward suggestions concerning changes to the service schedule to your supervisor.

The Monthly Quality Control Maintenance Checksheet (Figure I.1.2.1) should be completed weekly and forwarded monthly to your supervisor.

I.1.2.2 DAILY CHECKS

1. Verify that the "Power" and "Auto" switch lights are on. Check for adequate zero air pressure (>15 psig) and purge air pressure (>5 psig) on front panel of pneumatics chassis.

2. Record the timer program data in ppm in the appropriate column on the back of the checksheet.

3. Review the previous day's CSI calibrator data on the recorder's chart for indication of zero air supply (pneumatics chassis) malfunction such as contaminated zero air, or unusual span points (indicating inadequate zero air flow).

4. Check the three rotameters on the main panel of the electronics chassis for carrier air flow of 100 SCCM $\pm$ 25 SCCM. If air flow varies by more than $\pm$ 25 SCCM, determine the cause and correct.

I.1.2.3 WEEKLY CHECKS

1. Check the condition of the silica gel in the drier tubes. Replace the silica gel if 70% is light blue to white in color.

2. Check the proper operation of the following display select functions.

a. Time: Pressing the "Time" switch causes the time of day to be indicated.

NOTE: If in a calibration mode, the display shows elapsed time within a calibration step.

b. Oven: Pressing the "Oven" switch causes the permeation tube oven temperature to be indicated. The reading should be 30ºC ± 0.1ºC.

c. Flow: Pressing the "Flow" switch in the timer and precision modes causes the total gas flow through the mass flow controller to be indicated. This reading should be 5.0 SLPM ± 0.1 SLPM.

d. Ozone: Pressing the "Ozone" switch causes a display reading corresponding to the U.V. lamp output.

e. Diag: Pressing the "Diag" (diagnostic) switch causes the following functions to be indicated as directed by the rotary switch position on the RCP.

+ 5V Power Supply
+15V Power Supply
-15V Power Supply
5.00 Ozone Generator Temperature
5.00 Flow Control Setpoint

Check the above functions one-by-one by turning the rotary switch in the clockwise direction on the RCP.

I.1.2.4 BIWEEKLY CHECKS

1. Once every two weeks, initiate a Precision Program and record the data in ppm to three decimal places (from the primary data recovery system) on the front of the checksheet (Figure I.1.2.1). Perform the Precision Program so as not to interfere with daily maximum hourly averages or episode levels. The Precision Program data will be used for analyzer precision determinations required by the Environmental Protection Agency.

2. Verify that cooling fans in the electronics and pneumatics chassis are operating. Failure of either fan may result in overheating. Note any unusual fan and pump noises. A new noise or absence of a familiar noise can indicate a malfunction in the equipment.

I.1.2.5 THREE-MONTH CHECK

Contact your supervisor to arrange for a recalibration of the ozone generator. Use the procedure in Appendix I.3.

I.1.2.6 SEMI-ANNUAL CHECKS

1. Remove the cover to the permeation tube oven at the rear of the electronics chassis. This constant temperature oven houses two permeation tube channels. Replace high rate SO_2 permeation tube with a new certified tube, and affix a dated sticker on the oven cover. A new tube can be obtained from the Sacramento Support Facility.

2. Contact your supervisor to arrange for a recalibration of the mass flow controller and oven temperatures. Use the procedure in Appendix I.3.

3. Recalibrate oven temperatures.

I.1.2.7 ANNUAL CHECKS

1. Replace the particulate filter in the pneumatics chassis and affix a dated sticker to the new filter.

2. Remove the cover and replace the low rate SO_2 permeation tube with a new certified tube (obtainable from the Instrumentation and Standards Laboratory in Sacramento) and affix a dated sticker on the oven cover.

3. Replace the scrubber charcoal and affix a dated sticker on the scrubber. See Figure I.1.4.2 for assembly details.

TABLE I.1.2.1

Maintenance Schedule for the
CSI Precision Calibrator System

Parameter	Daily*	Weekly	Biweekly	Three Months	Semi-Annual	Annual
Power Lights On	X					
Zero and Purge Air Pressure	X					
Chart Traces and Carrier Flow	X					
“Timer” Program Data	X					
Display Select Functions		X				
Silica Gel condition		X				
“Precision” Program Data			X			
Replace Scrubber						X
Ozone Generator Recalibration				X		
Replace High Rate SO_2 Permeation Tube					X	
Mass Flow Controller Recalibration					X	
Oven Temperatures Recalibration					X	
Replace Particulate Filter						X
Replace Low Rate SO_2 Permeation Tube						X

*or each day the operator services the calibrator.

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECKSHEET
CSI PRECISION CALIBRATOR SYSTEM

Station Name:___________________________________Month/Year:______________________
Station Number:______________________________Technician:___________________________
Calibrator Prop. #:Pneum:______________Elect:__________Agency:_______________________

OPERATOR INSTRUCTIONS:

1. DAILY CHECKS: Power lights on. Zero air pressure >15 psig. Purge air pressure 5 psig. Zero air chart traces and carrier air flow normal. Record Timer Program data on the back of this datasheet.
2. WEEKLY CHECKS: Silica gel dry. Display select function properly operating.
3. BIWEEKLY CHECKS: Initiate Precision Program and record data below in ppm.

BIWEEKLY PRECISION CHECKS (PPM)			
Step No.	1	3	6
DATE	ZERO	LOW O_2	LOW SO_2

4. THREE-MONTH CHECKS: Recalibrate ozone generator. Date last calibrated___________
   True value______________________(Low O3)
5. SEMI-ANNUAL CHECKS: Replace high rate SO2 permeation tube. Date last replaced___________
   Recalibrate mass flow controller. Date last calibrated_______________
   Recalibrate oven temperature. Date last calibrated__________________
   Record high SO2 permeation rate________________________________
6. ANNUAL CHECKS: Replace particulate filter. Date last replaced________________________
   Replace low rate SO2 permeation tube. Date last replaced____________
   Record low SO2 permeation rate________________________________
   Record dilution flow____
   Replace scrubber. Date last replaced_____________________________
   Clean sampling inlet, probe, and manifold. Date last cleaned__________

DATE	COMMENTS OR MAINTENANCE PERFORMED

Reviewed By:_______________ Date:_________________

Figure I.1.2.1
Monthly Quality Control Maintenance Checksheet (Front)

Step No.	Concentration, ppm Timer Program						Comments
	1	2	3	4	5	6	
Day	Zero	High O_3	Low O_3	Zero	High SO_2	Low SO_2	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
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25							
26							
27							
28							
29							
30							
31							

Figure I.1.2.1
Monthly Quality Control Maintenance Checksheet (Rear)

I.1.3 NON-ROUTINE SYSTEM MODIFICATIONS

I.1.3.1 INCREASING/DECREASING PROGRAM STEP TIME - The program step time in minutes may be increased or decreased by adjusting the two, 10-position rotary switches on the RCP. The position of "Tens" and "Units" rotary switches determines the time duration in minutes for a programmed calibration step. For example, a setting of 2 on the "Tens" rotary switch and a setting of 5 on the "Units" rotary switch will yield program step time of 25 minutes.

I.1.3.2 INCREASING/DECREASING PROGRAM RECOVERY PERIOD - The recovery mode produces a span flag while the analyzers are stabilizing on ambient air. The program recovery period in minutes may be increased or decreased by adjusting the rotary switch marked zero to nine on the RCP (see Figure I.1.0.1).

I.1.3.3 INCREASING/DECREASING PROGRAM LIMIT PERIOD - The program limit period is the maximum time duration that the calibrator may remain out of the "Standby" mode. The program limit period in hours may be increased or decreased by adjusting a rotary switch marked from zero to nine on the RCP. At the end of the limit period, the current function is terminated and the calibrator is forced to the "Standby" mode immediately.

I.1.4 DETAILED MAINTENANCE PROCEDURES

I.1.4.1 CALIBRATOR CLEANING - The interior and exterior of the calibrator should be vacuumed and cleaned periodically to remove accumulated dust.

I.1.4.2 PUMP - the pneumatic chassis (CSI 1795) contains a Gast Model DOA Pump. Figure I.1.4.1 shows pump components and their assembly sequence. To clean or replace the pump filters and/or rubber gasket, remove the five Phillips head screws in the top of the pump. Clean the head gasket with water. Remove the filters, wash them in soap solution, rinse with distilled H_2O, and/or blow dry with air and reinstall.

NOTE: The gasket and top plate will fit in one position only.

To replace the diaphragm, remove the four socket cap screws from the head of the pump. Remove the two Phillips head screws, retainer plate and the diaphragm. The diaphragm will fit in any position on the connecting rod. Reinstall the plate with the two Phillips head screws.

For replacing the inlet and outlet valves, remove the slotted machine screw that holds each valve in place. The stainless steel inlet and outlet valves are interchangeable. Clean them with water and dry. When reinstalling the old or replacing the outlet valve, put the valve in place and note there is a retaining bar near the machine screw hole. This retaining bar holds the valve in position. When reinstalling the old or replacing the inlet valve, note that the valve holder is marked with an "X" in one corner. This "X" should be in the lower right hand corner toward the inlet of the air chamber. Replace the head and tighten the socket head screws. In addition, the following precautions should be undertaken while cleaning or replacing pump components:

1. Do not lubricate parts with oil, grease, or petroleum products nor clean with acids, caustics, or chlorinated solvents.

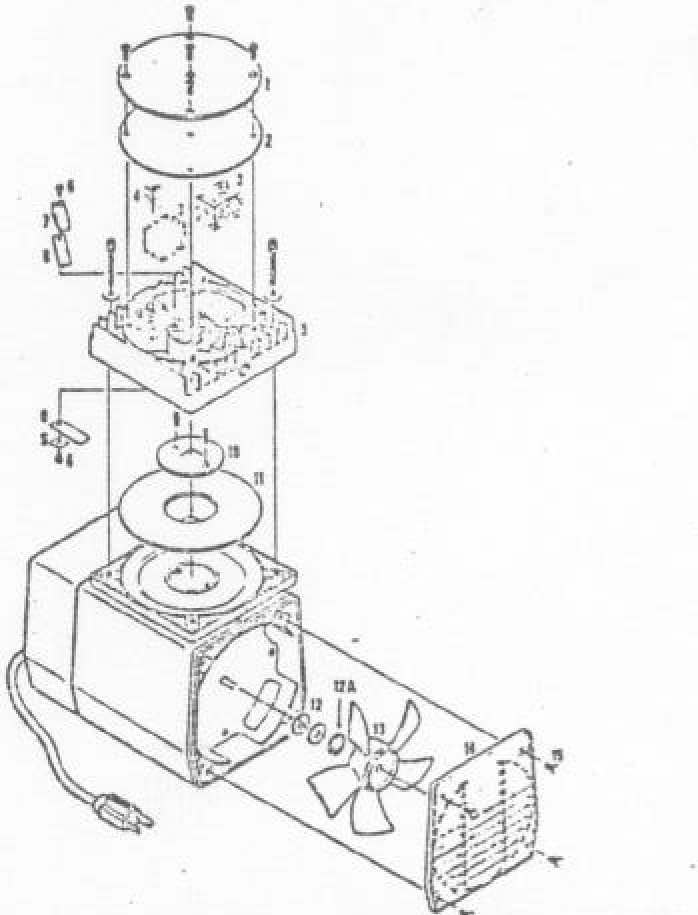
2. Be careful to keep the diaphragm from contacting petroleum products or hydrocarbons.

3. While replacing the diaphragm, do not raise burrs or nicks on the two Phillips head screws. These burrs could cause damage to the inlet valve. If after cleaning the unit and/or installing a new service kit (see Figure I.1.4.1) the unit does not operate properly, return the pump to the Instrumentation and Standards Laboratory in Sacramento.

I.1.4.3 SCRUBBER - The charcoal scrubber should be replaced every 12 months with normal usage. See Figure I.1.4.2 for assembly details.

I.1.4.4 OZONE GENERATOR - The ultraviolet lamp and the photo diode in the ozone generator degrade slowly. The ozone generator should start rapidly at low concentrations and have sufficient ozone output at high flow rates. The ozone output should be verified with an ozone transfer standard analyzer every three months. The U.V. lamp and the photo diode should be replaced, based upon quarterly performance results.

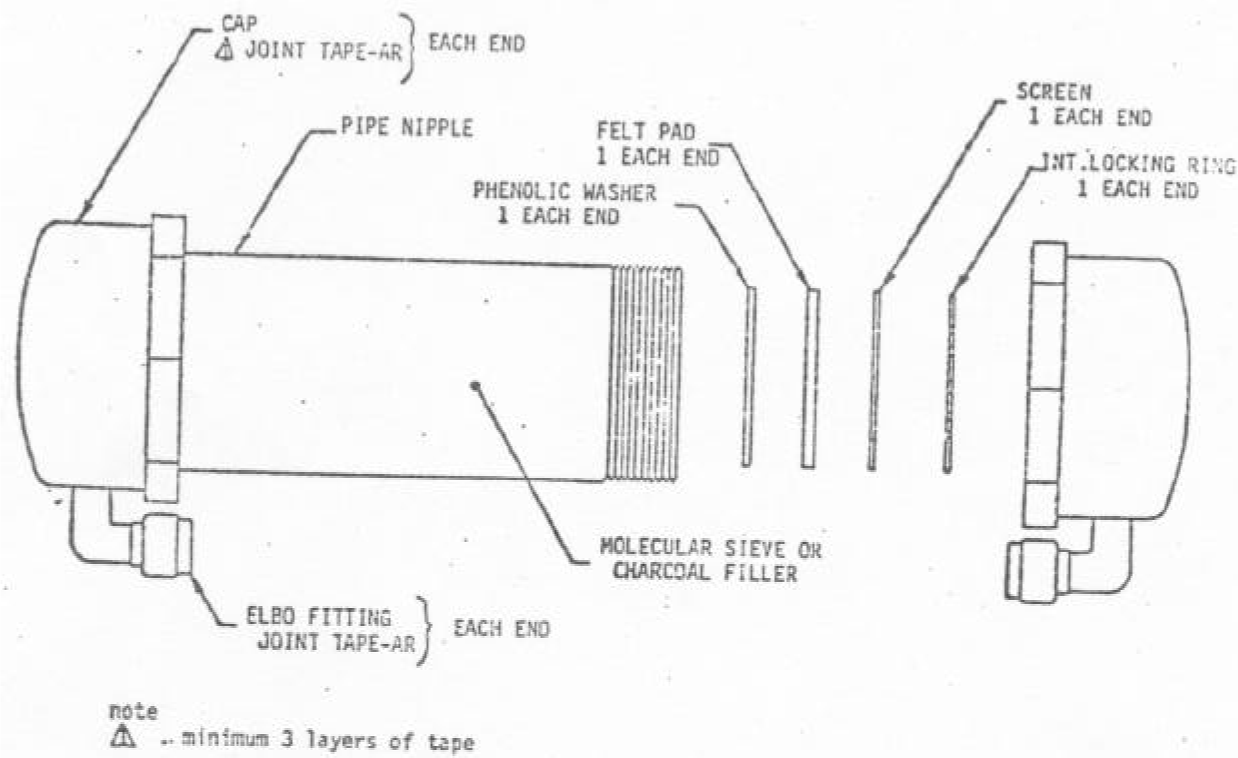
I.1.4.5 MASS FLOW CONTROL - The electronic chassis (CSI 1790) contains a Tylan Model FC-261 mass flow controller. The detailed information on the maintenance of the flow controller is provided in the Tylan Operation and Service Manual. This manual is supplied by the vendor as part of the calibrator accessory package.



REF. NO.	DESCRIPTION	PART NO.	Model DOA
1	COVER	AF808	1
• 2	HEAD GASKET	AF820	1
• 3	FILTER/MUFFLER ELEMENT	AF938A	2
• 4	FILTER ELEMENT	AF857A	1
5	HEAD	AF804	1
• 6	VALVE SCREW	BB309	2
• 7	VALVE RETAINER	AF856	1
• 8	LEAF VALVE	AF817	2
9	VALVE RETAINER	AF819	1
10	RETAINER PLATE	AF809	1
11	DIAPHRAGM	AF818A	1
12	FELT SPACER	AA929	2
12A	SPACER	AG970	1
13	FAN	AF533	1
**13A	FAN	AF533A	
14	GRILLE	AF807	1
15	RIVET	AE945	4

• Indicates parts included in Service Kit C585-0033

Figure I.1.4.1
Gast Model DOA Pump



NOTE: The entire scrubber is to be replaced. The new scrubber will have standoffs to be installed on the scrubber-holder. These standoffs will make it easier to secure the scrubber.

Figure I.1.4.2
Scrubber Assembly Details

I.1.5 TROUBLESHOOTING

I.1.5.1 GENERAL INFORMATION - The manufacturer's instruction manuals contain detailed information pertaining to troubleshooting and should be your first source of information. Space is provided on the Monthly QC Checksheet for recording malfunctions, causes, fixes, and actions taken to prevent reoccurrence.

Cautions listed in Section I.1.0.6 should be observed while performing troubleshooting or maintenance on the calibrator.

I.1.5.2 ELECTRONIC CHASSIS (CSI 1790) MALFUNCTIONS - Refer to Section 5.7 (General Troubleshooting) in operation and service manual.

I.1.5.3 PNEUMATIC CHASSIS (CSI 1795) MALFUNCTIONS - Refer to Section 5 (Troubleshooting and Repair) in operation and service manual.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX I.2

ACCEPTANCE TEST PROCEDURE
FOR THE
COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM

MONITORING AND LABORATORY DIVISION

JUNE 1982

I.2.0 PROCEDURE

I.2.0.1 GENERAL INFORMATION - Before beginning acceptance testing of the CSI Calibrator System, read the manufacturer's operating and service manuals. Then, initiate an instrument log book and an acceptance test mini-report (Figure I.2.0.1).

I.2.0.2 PHYSICAL INSPECTIONS - Unpack the calibrator system from its shipping containers and check for shipping damage. Report any damage observed to your supervisor. Perform the following checks:

1. Check for loose circuit boards, relays, switches, solenoid valves, fittings, etc.

2. Verify that the calibrator system is outfitted with all the hardware, including slides and brackets, necessary for mounting in a 19" wide by 25" deep relay rack.

3. Verify that the calibrator is complete upon receipt (i.e. manuals, drier tubes, umbilical cable, etc.).

I.2.0.3 INITIAL PERFORMANCE CHECK - Set up the calibrator system by following the Installation Procedure in Appendix I.1 - Station Operator's Procedures. Perform the following checks.

1. Check for adequate zero air pressure (>15 psig) and purge air pressure (>5 psig) as measured by pressure gauges on the front panel of the pneumatics chassis.

2. Check the performance of display select functions (see Section I.1.2.3). Verify that ozone generator oven temperature and permeation oven temperature are fixed at 50ºC ± 0.1ºC and 30ºC ± 0.1ºC, respectively. Verify that the dilution air flow rate is set at 5 SLPM and controlled to within 0.01 SLPM on calibrator display.

3. Check the performance of various calibrator functions. With the switches on the Recessed Control Panel (RCP) verify that the program dip switches, program advance, step time, recovery period, limit period and manual control adjustment functions are in proper working order (see Section I.1.0 and I.1.3).

4. Check the attitude sensitivity of the flow meter. The flow should remain with $\underline{+}$3% at zero and at any point in the flow range of the meter for up to a 45º altitude change in either vertical or horizontal plane.

5. Contact Closures - Verify that the calibrator system is provided with contact closure outputs so that they can be outputted to the data loggers (Monitor Labs Model 9300 or 9400).

I.2.0.4 OPERATIONAL TESTS - Perform the following operational tests and record the results on the strip chart and the mini-report as a permanent record of the tests performed (comments in ink). File the charts and the test report in the Air Quality Surveillance files under the assigned ARB property number.

1. Temperature/Voltage Tests - Place the calibrator in the environmental chamber and connect the analyzer power cord to the variable voltage power strip. While generating a stable concentration of SO_2 (0.40 $\underline{+}$ 0.05 ppm) and O_3 (0.50 $\underline{+}$ 0.10 ppm) as read by calibrated analyzers, perform the standard temperature/voltage run (Thermotron Program #7) and record the following parameters:

   a. Mass Flow Meter Response - Monitor and record the external mass flow meter response by connecting "Cal Gas Out" port on rear of CSI 1790 through a calibrated Matheson flow meter to the sampling manifold.

   b. Analyzers Response - Monitor SO_2 and O_3 outputs in manual mode with Teco 43 or Meloy SA 700 and Dasibi 1003-AH calibrated analyzers, respectively.

   The changes in the concentration of the generated calibration gases due to temperature variations should not vary more than $\underline{+}$3.6% of full scale for both SO_2 and O_3.

   The changes in the concentration of the generated calibration gases due to voltage variations should not vary more than $\underline{+}$0.003 ppm SO_2 and $\underline{+}$0.005 ppm O_3.

Turn off the power and remove the CSI calibrator system from the environmental chamber and set on a flat surface (see Section I.1.1.2).
After a few minutes, restore the power to the calibrator. Upon resumption of power, the calibrator should automatically restart in the standby mode.

2. Mass Flow Meter Linearity Test - In the manual mode, perform a mass flow meter calibration against a transfer standard Matheson Flow Meter. Adjust the mass flow meter span and zero controls if mass flow meter linear regression has an intercept greater than $\pm$0.1 SLPM or a slope outside of 1.00 $\pm$ 0.02. During calibration, record both display and analog output readings. Check the output in zero, O_3, and SO_2 modes to insure that the air flow is the same.

3. Zero Air Supply and Purity - The air purification system consists of a pump, water trap, particulate filter, air driers, ozone generator (to convert NO to NO_2), and scrubber to remove SO_2, NO_2, and O_3.

   Verify that at 10 SLPM, the zero air purity during periods of high ambient NO meets or is less than the following specifications:

   SO_2 < 2 ppb
   NOx < 2 ppb
   O_3 < 2 ppb

4. Calibrator System Stability Tests - Connect the calibrator outlet to the sample manifold inlet farthest from the end of the probe inlet. This will allow the CSI calibrator output to purge the sample manifold. Connect a TECO 43 or Meloy SA 700, a Dasibi 1003-AH, and a TECO 14B to the sample manifold. Initiate the timer program on the CSI calibrator and operate continuously for seven days. During the seven-day period, manually activate the precision mode daily by depressing the "Prec" push button switch on the CSI main panel.

   At the end of the seven-day tests, check the zero and span points drift of the SO_2 and O_3 analyzers. Verify that the timer actuated calibrations were performed daily at the same time and that the calibration points recorded are at their proper levels. Maximum allowable drift for SO_2 is $\pm$1% of the reading corrected for analyzer drift.

   Verify that the SO_2 and O_3 concentrations are the same in both timer and precision modes.

5. Ozone Generator Output - In manual mode, check the range of the ozone generator. It should be 0.03 ppm to 1 ppm at 5 SLPM. The ozone generator output drift should not exceed $\pm$2% at 0.5 ppm per week.

6. Final Review - If the tests are satisfactory, complete an equipment relocation notification and record pertinent information such as flow setting, etc., in the log book and on the acceptance test "mini-report".

   Record equipment numbers, date completed, and other appropriate information. The analyzer is now ready for field use.

COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATION SYSTEM
ACCEPTANCE TEST "MINI-REPORT"

Date______________Make and Model No.___________________ Serial No._______________
By_______________________ARB No._______________Reviewed By__________________
Date of Acceptance___________________

		Passed	Failed	Final OK*
I.	PHYSICAL INSPECTIONS			
	A. Checked for shipping damage......................................	______	______	________
	B. Checked electrical wiring...	______	______	________
	C. Checked solenoid valves and loose components............	______	______	________
	D. Checked plumbing for leaks...	______	______	________
	E. Calibrator complete upon receipt...................................	______	______	________
II.	PERFORMANCE CHECKS			
	A. Checked zero and purge air pressure.............................	______	______	________
	B. Checked performance of display select functions...........	______	______	________
	C. Checked operation of various functions on RCP...........	______	______	________
	D. Checked flow meter linearity (calibration attached).......	______	______	________
	E. Checked flow meter attitude sensitivity.........................	______	______	________
	F. Checked contact closure outputs..................................	______	______	________

III. OPERATIONAL TESTS (Attach Charts)

	15ºC	35ºC	Passed	Failed	Final OK*
A. Temperature and voltage variation Chamber temperatureº C					
1. Shift in mass flow meter response (%FS).	____	____	_____	______	_______
2. Shift in SO_2 analyzer response (%FS)...…	____	____	_____	______	_______
3. Shift in O_3 analyzer response (%FS)........	____	____	_____	______	_______
B. Calibrator system stability SO_2 and O_3 (<±1% of reading)..……			_____	______	_______
C. Zero air purity (<2ppb SO_2, O_3, No_x)............................…			_____	______	_______
D. Weekly ozone generator output drift (<±2% at 0.5ppm)..……			_____	______	_______

IV. SPECIAL TESTS

V. COMMENTS/MAINTENANCE PERFORMED

*Indicate corrective action taken.

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Figure I.2.0.1
CSI Calibrator System Acceptance Test Mini-Report

COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM
ACCEPTANCE TEST "SUMMARY SHEET"

Step No.	Timer Mode Checks						Precision Mode Checks						Comments
	1	2	3	4	5	6	1	2	3	4	5	6	
Date	Zero	High O_3	Low O_3	Zero	High SO_2	Low SO_2	Zero	High O_3	Low O_3	Zero	High SO_2	Low SO_2	

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Figure I.2.0.2
CSI Calibrator System Acceptance Test Summary Sheet

STATE OF CALIFORNIA

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VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX I.3

CALIBRATION PROCEDURE
FOR THE
COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM

MONITORING AND LABORATORY DIVISION

FEBRUARY 1983

I.3.0 OVERVIEW

I.3.0.1 THEORY - An ozone transfer standard certified against a primary standard laboratory ultraviolet photometer is used in calibrating the CSI calibrator ozone generator. Air flow transfer standards (mass flow meters or equivalent), certified against a primary standard flow rate calibrator, are used in the mass flow controller calibration. An NBS temperature sensor is used in calibrating the permeation oven temperature.

I.3.0.2 APPARATUS

1. Dasibi Model 1003-PC ozone analyzer/calibrator, or equivalent

2. 0.2-10 SLPM air flow transfer standard (Matheson mass flow meter)

3. One-quarter inch Teflon tubing for air flow connections

4. Three stainless steel Swagelock caps and three Swagelock plugs (1/4")

5. Digital voltmeter with test leads preferably alligator clip leads) capable of reading 0-15 DC with 0.01 VDC resolution

6. Calibration Report Forms (Figures I.3.1.1 - I.3.1.4)

7. NBS traceable temperature sensor

8. Cotton or other insulation material

9. A 12" piece of 24 AWG wire with a hook on the end to access permeation tubes

I.3.1 AS-IS CALIBRATION

PRIOR TO THE AS-IS CALIBRATION, MAKE NO REPAIRS OR ADJUSTMENTS TO THE CALIBRATOR. A complete as-is calibration involves the tests documented in this section. On partial as-is calibrations (ozone generator only, mass flow controller only, permeation oven only), always perform the leak check.

I.3.1.1 0.2-10 SLPM MASS FLOW CONTROLLER

1. Connect the Matheson mass flow meter (transfer standard) to AC power. Allow it to warm up for one hour. The CSI calibrator should be on and operating for at least two hours.

2. Record the mass flow meter and calibrator property numbers, the transfer standard's calibration slope and intercept, and other pertinent information on the Calibration Datasheet, PTSD-54, (Figure I.3.1.2).

3. Disconnect the CSI calibrator CAL GAS OUT line from the sample manifold and cap the manifold port. Attach the line from the CAL GAS OUT port of the CSI calibrator to the input of the transfer standard. The transfer standard outlet should be open to the atmosphere.

4. On CSI 1790, set the Calibration Mode switch to MANUAL, the Display Select switch to FLOW, and the Manual Select switch to ZERO.

5. Set the Manual Control switch on RCP to Variable.

6. Adjust the Manual Flow knob on CSI 1790 to read 9.50 SLPM. After the transfer standard reading stabilizes, record both the CSI display reading and the transfer standard reading on the Calibration Datasheet PTSD-54, (Figure I.3.1.2).

7. Repeat Step 6 at Manual Flow knob settings of 7.5, 5.0, 2.5, and 1.0.

8. Set the Manual Control switch to RCP to Preset and record the CSI display reading and the transfer standard reading on the Calibration Datasheet.

9. Obtain the linear regression constants Slope and Intercept from the previous Calibration Datasheet for the following equation:

   $$\text{True Air Flow Rate} = \underset{\text{(Slope)}}{\underline{\qquad}} \times \text{Manual Flow Knob Set Point} \pm \underset{\text{(Intercept)}}{\underline{\qquad\quad}}$$

10. Calculate the previous True Air Flow Rate using the above equation for each Manual Flow knob set point.

11. Using either the transfer standard calibration equation or the transfer standard calibration curve, convert the transfer standard readings to the True Air Flow Rates.

12. Plot the Manual Flow knob setting versus True Air Flow Rate for each calibration point.

13. Calculate the summation of the previous True Air Flow Rates (S2), and the current True Air Flow Rates (S1). Then calculate the percent deviation from the previous calibration as follows:

$$\text{Percent Deviation from Previous Calibration} = \frac{S1 - S2}{S2} \times 100$$

14. Calculate the new linear regression constants Slope and Intercept for the current calibration using the following equation:

$$\text{True Air Flow Rate} = \underset{\text{(Slope)}}{\_\_\_\_\_\_} \times \text{Manual Flow Knob Set Point} \pm \underset{\text{(Intercept)}}{\_\_\_\_\_\_\_\_}$$

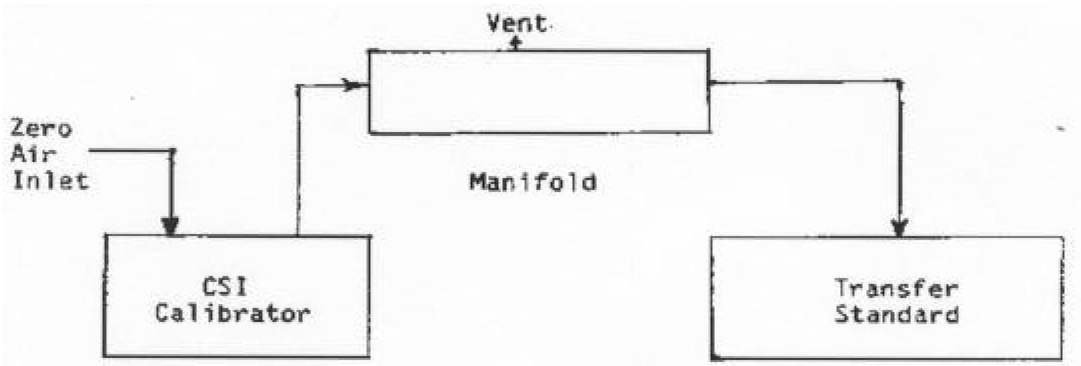
I.3.1.2 OZONE GENERATOR

1. Connect the ozone transfer standard to an AC power supply and turn it on. While sampling air through a charcoal scrubber, allow the ozone transfer standard to warm up for at least one hour. The CSI calibrator should be on and operating for at least two hours.

2. Record the ozone transfer standard and calibrator identification numbers, settings, and other pertinent information on the Ozone Generator Calibration Datasheet (Figure I.3.1.3).

3. Adjust the sample air flow rate on the ozone transfer standard to 2.5 SLPM. Record the flow meter setting and the true air flow on the Calibration Datasheet. Leak check the ozone transfer standard by capping the sample inlet. If there are no leaks, the flow meter ball should go to zero. After the leak checks and repairs of any leaks, reconnect the charcoal scrubber to the ozone transfer standard's inlet.

4. Connect the transfer standard to the sample manifold as shown in the schematic below.



5. Depress the MANUAL Mode switch located on the CSI 1790 main panel (see Figure I.1.0.1), and set the manual control on RCP to the VARIABLE position.

6. Select ZERO calibration gas and adjust the Manual Flow knob to display reading corresponding to the True Air Flow Rate of 5.0 SLPM.

7. After the ozone transfer standard is warned up (control frequencies stable), record 10 consecutive digital display values in the respective column labeled "Zero Air". Calculate the sum and the average of the 10 numbers and record the values on the Calibration Datasheet, PTSD-55, (Figure I.3.1.3) in the respective blocks. The average value shall also serve as the transfer standard zero correction.

8. Select HIGH OZONE and depress OZONE push button on the "Display Select".

9. Adjust the Manual Ozone Control knob to display 2.50 (Ozone Display Guide Number).

10. Allow the transfer standard response to stabilize. Record 10 consecutive transfer standard digital display readings in the appropriate blocks on the Calibration Datasheet.

11. Repeat Steps 9 and 10 for ozone guide number display reading of 0.45.

12. Set the Manual Control on RCP to the PRESET position.

13. Select HIGH OZONE, allow transfer standard response to stabilize, and record 10 consecutive transfer standard digital display readings in the appropriate blocks on the Calibration Datasheet.

14. Select LOW OZONE, allow transfer standard response to stabilize, and record 10 transfer standard digital display readings on the Calibration Datasheet.

15. Calculate corrected average ozone values for the transfer standard at each setting using the formula:

    Corrected Average (A) = (average reading - zero correction) x true ozone correction factor x altitude correction factor (see Table I.3.1.1 for the Altitude Correction Factor.)

16. At each set point, calculate and record the percent deviation from the previous calibration using the following equation:

    Where B is the previous calibration, and A is the present calibration.

    $$\text{Percent Deviation} = \frac{(A - B)}{B} \times 100$$

17. Generate a curve of display guide numbers versus actual ozone concentration measured (ppm).

I.3.1.3 PERMEATION OVEN

Calibration of the permeation oven consists of accurately setting the operating temperature. The CSI Model 1790 oven is designed to operate at 30ºC $\pm$0.1ºC over an ambient temperature range of 15 to 35ºC. An NBS traceable temperature sensor that can be read to $\pm$0.1ºC is to be used during calibration.

1. Remove the permeation assembly cover located on the rear panel (see Figure I.3.1.5).

2. Remove the cap from the end of one tube holder.

3. Extract the front Teflon spacer from the holder. A 12" piece of 24 AWG wire with a hook on the end can be used for this purpose.

4. The permeation tube, if present, can be removed with the same piece of wire. Store removed permeation tubes in a plastic tube.

5. Depress the OVEN temperature switch on the front panel display.

6. Install an NBS traceable temperature sensor into the tube holder so that the bulb or sensing element extends five to seven inches into the tube. If the sensor is small in diameter compared to the inside diameter of the tube, stuff some cotton or other insulation into the end of the tube to minimize connection currents.

7. Allow 10 to 15 minutes for thermal equilibrium, then read the temperature sensor and record.

8. Perform Steps 1 through 7 on the second tube holder.

9. Restore the permeation oven to its original configuration.

I.3.1.4 RESULTS EVALUATION - A final calibration is required when the tolerances listed in Table I.3.1.2 are exceeded. If no tolerances are exceeded, then perform the following tasks:

1. Complete the calibration curves for the mass flow controller and the ozone generator.

2. Complete the Calibration Report cover sheet and the calibration graph for mass flow controller and the ozone generator. Forward a copy of the completed calibration report to the Quality Assurance Section in Sacramento, within seven days of the end of the month in which the calibrations were performed. This will insure that the monthly analysis will be performed in a timely fashion.

Table I.3.1.1

Altitude Correction Factors

Elevation (feet above sea level)	Altitude Correction Factor (ACF)
0	1.000
500	1.000
1000	1.037
1500	1.056
2000	1.075
2500	1.095
3000	1.116
3500	1.136
4000	1.158
4500	1.179
5000	1.202
5500	1.225
6000	1.248
6500	1.272
7000	1.296
7500	1.321
8000	1.347
8500	1.372
9000	1.399
9500	1.426
10000	1.454

Table I.3.1.2
As-Is Calibration Tolerances

ITEM	PARAMETER	TOLERANCE
0.2-10 SLPM MFC	True Air Flow Rate Calibrator Display Reading	5.0±0.1 SLPM Within ±0.1 SLPM of flow reading which corresponds to a True Air Flow Rate of 5.0 SLPM
Ozone Generator	Ozone Output	0.50±.05 ppm high O_3 0.09±.01 ppm low O_3
Permeation Oven Temperature Check		30ºC±0.1ºC

CALIFORNIA AIR RESOURCES BOARD
CSI PRECISION CALIBRATOR
CALIBRATION REPORT

To:______________________________ Log Number:_____________________
From:____________________________ Certification Number:_______________
Date of Report:____________________

IDENTIFICATION

Station Name:	Electronics Chassis:
Station Code:	Pneumatics Chassis:

CALIBRATION RESULTS

	Flow Controller	Ozone Generator	Oven Temperature
Final Calibration Rate			
%Deviation from Previous Calibration			

CALIBRATION SUMMARY

Mass Flow Meter				Ozone Generator			
Variable on RCP		Preset on RCP		Variable on RCP		Preset on RCP	
Flow Knob Setting	True Flow SLPM	CSI Display	True Flow	Ozone Level	Conc.* ppm	Ozone Level	Conc.* ppm
9.5		////////////	////////////	2.50		High O_3	
7.5		////////////	////////////	0.45		Low O_3	
5.0				////////////	////////////	////////////	////////////
2.5		////////////	////////////	////////////	////////////	////////////	////////////
1.0		////////////	////////////	////////////	////////////	////////////	////////////

*Zero Air Flow fixed at 5.0 SLPM

Comments____
____

Calibrated By:_______________________________ Checked By:____________________

PTSD-53 (2/83)

Figure I.3.1.1
CSI Precision Calibrator - Calibration Report

CALIFORNIA AIR RESOURCES BOARD
CSI PRECISION CALIBRATION
MASS FLOW CONTROLLER CALIBRATION DATASHEET

Date_______________________________ As Is Calibration______________________
Log Number________________________ Final Calibration_____________________
Station Number________________________
Calibrator Property Number: Electronics_______________ Pneumatics_____________________

0.2 - 10 SLPM MASS FLOW CONTROLLER
Transfer Standard Make and Model No.____
Transfer Standard Property No.____
True Air Flow Rate*________________Transfer Standard Reading± _________________________
(slope) (intercept)
Calibration Information from Previous Datasheet, dated__________________________________
Previous True Air Flow Rate*_______________Flow Knob Set Point± ______________________
(slope) (intercept)

DATA NOTATION	As-Is/ Final	As-Is/ Final	As-Is/ Final	As-Is /Final	As-Is/ Final	As-Is/ Final
Manual Flow Knob Set Point	9.5	7.5	5.0	2.5	1.0	Preset Flow
CSI Display Reading						
Previous True Air Flow Rate						
Transfer Standard Reading						
True Air Flow Rate						

Summation of Previous True Air Flow Rates, S_2 =
Summation of True Air Flow Rates, S_1 =
%Deviation from Previous Calibration = $\frac{S_1 - S_2}{S_2} \times 100$

Linear Regression Equation:
True Air Flow Rate =____________________ Flow Knob Set Point± __________________
(slope) (intercept)

Comments____
____
Date Last Calibrated______________ Calibrated By______________Checked By_______________
PTSD-54 (2/83)

Figure I.3.1.2
Mass Flow Controller Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD
CSI PRECISION CALIBRATION SYSTEM
OZONE GENERATOR CALIBRATION DATASHEET

Date_____________________________ As Is Calibration____________________
Log Number_______________________ Final Calibration_____________________
Location__________________________ Station Number_____________________

Make and Model:_____________________ Property No.___________________
Property No.:________________________ Serial No.____________________
Samp.Freq.(Display)____(Initial)____(Final) Property of:___________________
Cntrl.Freq.(Display)_____(Initial)____(Final) Flow Setting:_____________________
Air Flow______SLPM@______Flow Setting Digital Output:____________________
Span Setting(Dial)___(Display)__(Offset)____
True O_3 Correction Factor(TOCF)____Altitude C.F.____

DATA NOTATION		As-Is /Final	As-Is /Final	As-Is /Final	As-Is /Final	As-Is /Final	As-Is /Final
Manual Control Switch Position		Variable on RCP			Preset on RCP		
Applicable Ozone Level Display		Zero Air	2.50	0.45	Zero Air	High O_3	Low O_3
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
Summation							
Average							
Zero Correction							
Correction Average*, A							
Previous Corrected Average*, B							
%Deviation from Previous							

*Corrected Average (Transfer Standard) = (Average Reading - Zero Correction) x TOCF x Altitude Correction Factor
**%Deviation from previous calibration = [(A-B)/B]x100, calculated for each ozone level setting
Previous Calibration Date_______________Barometric Pressure________________Temperature_______________
Comments____
Calibrated By__________________Checked By_________________

Figure I.3.1.3
Ozone Generator Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION GRAPH

Log No.: ______________

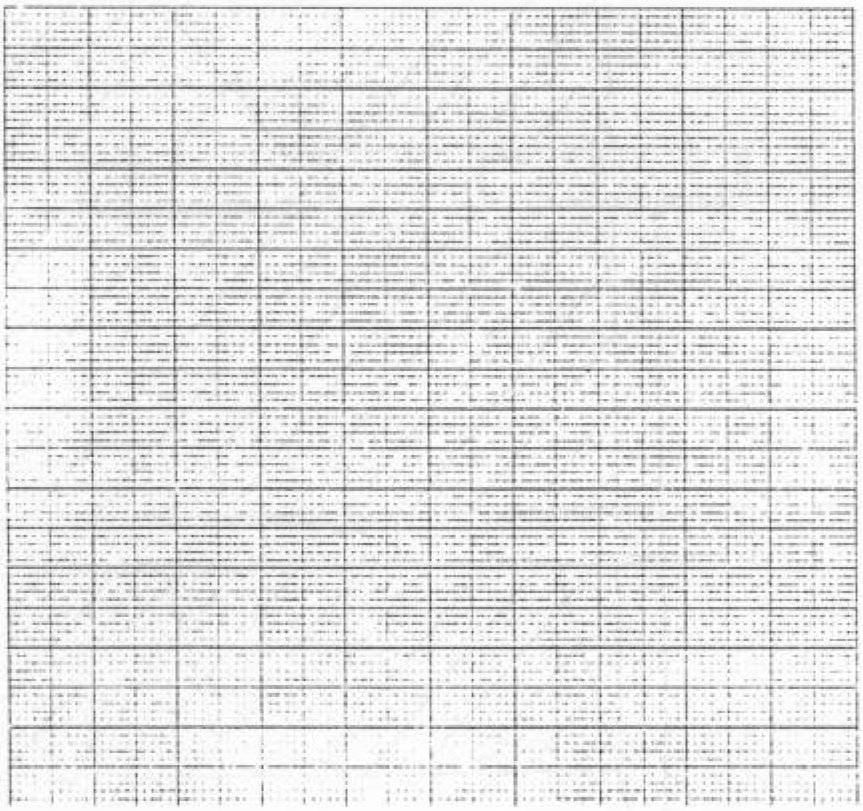
Station Name: ____________________ Date of Calibration: ______________

Station Site No.: ________________ "As Is" Calibration: ______________

Instrument Property No.: __________ "Final" Calibration: ______________

Instrument Make and Model No.: ____

MANUAL FLOW KNOB SETTING
OZONE DISPLAY GUIDE NUMBER



TRUE AIR FLOW RATE, SLPM
TRUE OZONE CONCENTRATION, PPM

COMMENTS: ____

____

____

Graph prepared by ______________

TSD-57 (2/83)

Figure I.3.1.4
CSI Calibration Graph

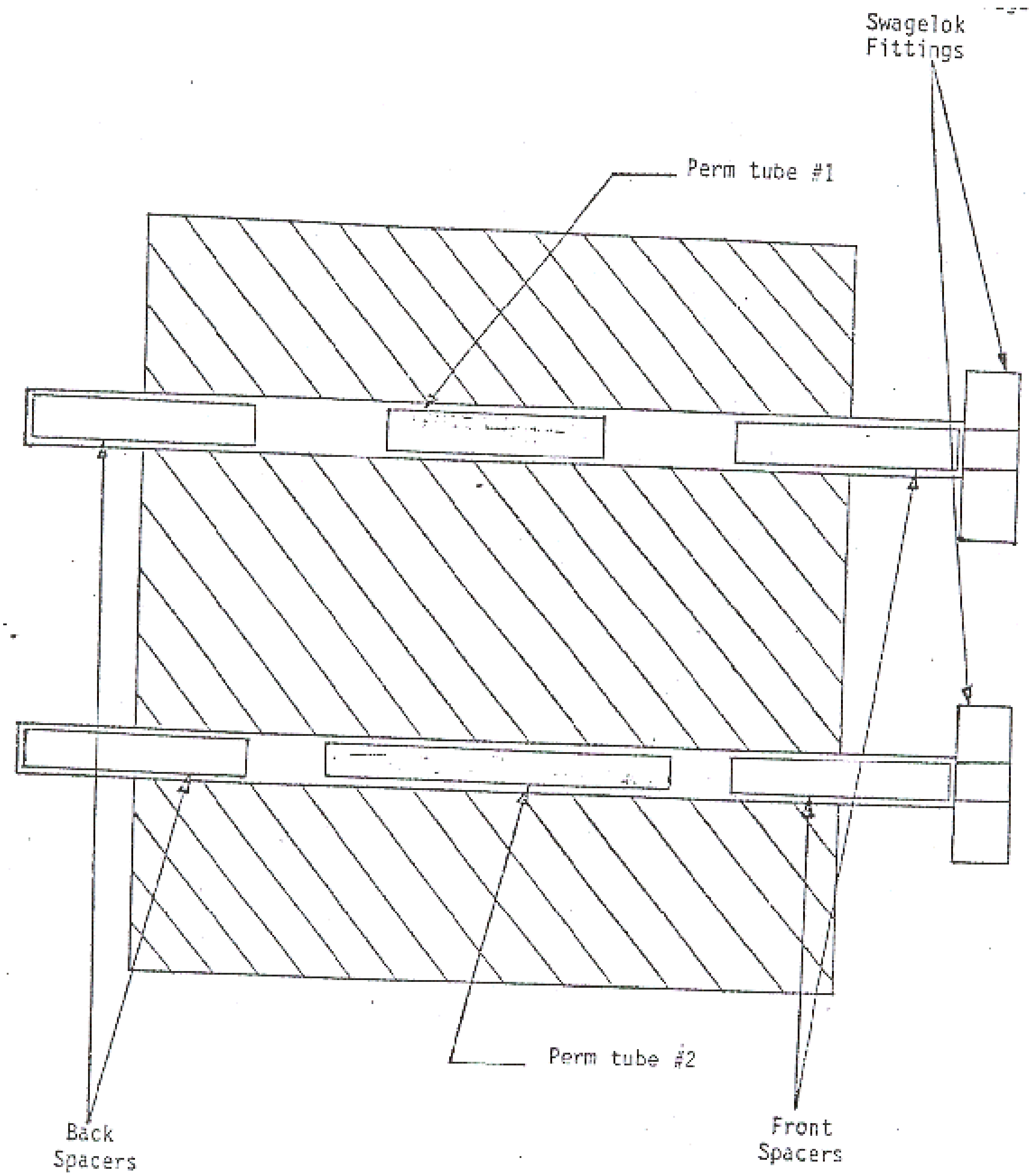


Figure I.3.1.5
Schematic Diagram of Permeation Oven

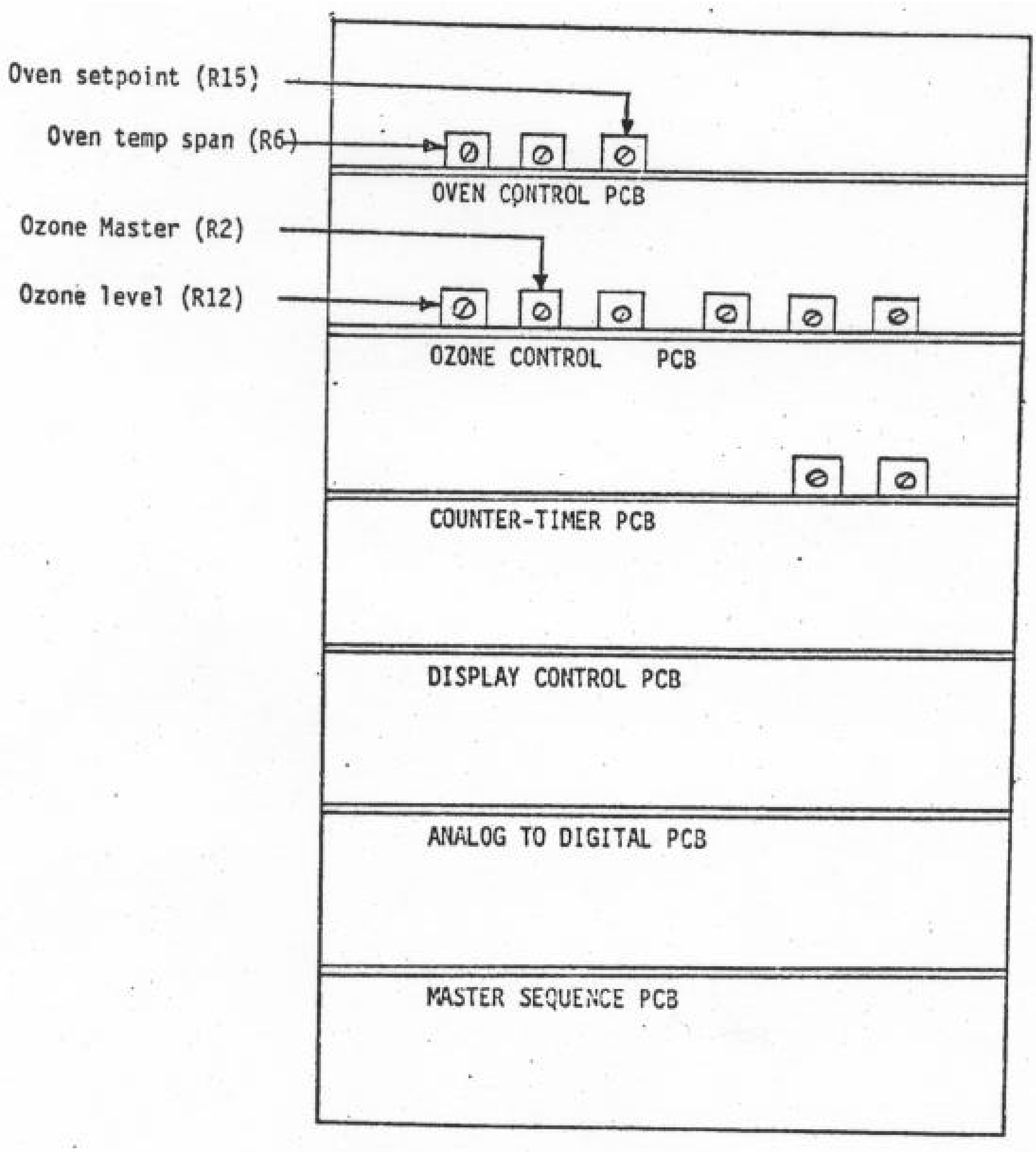


Figure I.3.1.6
Card Cage Layout Diagram

I.3.2 FINAL CALIBRATION

This section outlines procedures to insure that: (a) the flow controller setting agrees with the True Air Flow Rate, and the calibrator digital display agrees with the True Air Flow Rate; and (b) the ozone output and the permeation oven temperature are within the tolerances specified in Table I.3.1.2.

I.3.2.1 0.2-10 SLPM MASS FLOW CONTROLLER (MFC)

1. If the MFC's flow rate agrees with the True Air Flow Rate within the specified tolerances shown in Table I.3.1.2, skip Steps 2 and 3 of the following procedure. If it does not agree, perform Steps 1 through 4 of Section I.3.1.1, and then proceed with the following procedures:

2. Depress the MANUAL mode switch and set the MANUAL CONTROL on RCP to PRESET. Select ZERO CALIBRATION GAS and set the "Total Flow Preset" on RCP until transfer standard indication corresponds to a True Air Flow Rate of 5.0 SLPM.

   NOTE: Perform Step 3 if the calibrator digital display does not agree with the True Air Flow Rate within a ±2% tolerance.

3. If the proper flows or digital display value cannot be obtained, an internal adjustment of the calibrator mass flow controller may be required. Contact the Air Monitoring Support Section for further instructions.

4. After the calibrator digital display has been properly adjusted, or if no adjustment was required, perform Steps 5, 6, 7, 8, 11, and 14 of Section I.3.1.1 and all of Section I.3.1.4.

I.3.2.2 OZONE GENERATOR

1. If the ozone generator output is within the specified tolerances shown in Table I.3.1.2, skip Steps 2, 3, 4, 5, 6, and 8 of the following procedures. If it does not agree, perform Steps 1 through 8 of Section I.3.1.2, and then proceed with the following procedures:

2. Adjust the Manual Ozone control knob to read 5.0 and allow the transfer standard response to stabilize.

3. Adjust the OZONE MASTER control (R2) on the OZONE CONTROL P.C. board (see Figure I.3.1.6) until the measured concentration corrected for true ozone is 0.50 ppm. Then adjust the OZONE LEVEL control (R12) on the OZONE CONTROL P.C. board (see Figure I.3.1.6) until the digital display on CSI 1790 reads 2.5 ppm.

4. Set the Manual Control on RCP to PRESET position.

5. Adjust the HI OZONE pot on RCP (see OZONE PRESET in (Figure I.1.0.1) until the measured concentration corrected for true ozone is 0.50 ppm.

6. Select LOW OZONE and adjust the LOW OZONE port on RCP (see OZONE PRESET in Figure I.1.0.1) until the measured concentration corrected for true ozone is 0.09 ppm.

7. After the OZONE MASTER control, OZONE LEVEL control, HI ozone pot, and LO ozone pot have been properly adjusted, or if no adjustment was required, perform Steps 9 through 15 of Section I.3.1.2 and all of Section I.3.1.4.

I.3.2.3 PERMEATION OVEN

1. If the recorded permeation oven temperature readings are within 30 $\pm$ 0.1ºC , skip the remaining steps of this section.

2. If the temperature reading in the tube being tested is not 30ºC, note the display temperature and adjust the OVEN SETPOINT CONTROL (R15) on the permeation oven controller P.C. board (see Figure I.3.1.6).

3. Allow five to 10 minutes for stabilization, then recheck the temperature.

4. If the error is still too large, repeat Steps 2 and 3 until the error is reduced to less than 0.1ºC.

5. Once the temperature is properly set, adjust the OVEN TEMP SPAN control (R6) to make the digital display agree with the temperature sensor reading (see Figure I.3.1.6).

6. Repeat Steps 2 through 5 for the second tube holder if the temperature reading is in error from 30ºC by more than 0.1ºC.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX I.4

DATA EVALUATION PROCEDURES
FOR THE
COLUMBIA SCIENTIFIC INDUSTRIES PRECISION CALIBRATOR SYSTEM

MONITORING AND LABORATORY DIVISION

JUNE 1982

I.4.0 GUIDELINES FOR REVIEWING DATA

I.4.0.1 STRIP CHARTS - This section provides guidelines for reviewing the calibrator traces on the strip chart.

1. Check the daily zeros for indication of contaminated zero air. Compare the day-to-day zeroes against a known zero air source to rule out possible air purification system (pneumatic chassis) malfunctions.

2. At fixed flow setting of 5.0 SLPM, day-to-day SO_2 and O_3 concentrations in Timer and Precision modes should be identical. Excessive differences between concentrations generated in the Timer and Precision modes may indicate an electronic malfunction and should be investigated.

3. A gradual reduction in the zone generator output or variations in high and low ozone output may indicate that the ozone generator needs to be recalibrated. See the section on ozone generator calibration (Appendix I.3) for further details.

4. Reading should be taken to three decimal places for SO_2 and O_3. For example, O_3 - 0.090 ppm.

I.4.0.2 MONTHLY DATA ANALYSIS - The Quality Assurance Section will perform a statistical analysis of the data recorded on the Monthly Checksheet. The following information should be helpful in reviewing the monthly analysis.

1. Daily Timer Program - The graphs of percent difference versus day of the month may be used to evaluate analyzer response trends. Control limits are set at $\pm$15%. If an analyzer response falls outside of these limits, air quality data will be withheld, pending evaluation and correction, from data processing. Therefore analyzer corrective action is to be taken prior to exceeding the control limits.

2. Statistics Printout - The statistics printout can be used to evaluate the performance of the calibrator mass flow controller and the ozone generator. If abnormally high positive or negative percent differences at the low point in the Timer or Precision modes for SO_2 and O_3 are obtained, the CSI's mass flow controller may need to be recalibrated. The gradual reduction in ozone generator output or variations in high and low ozone output may indicate that the ozone generator output is deteriorating and needs to be recalibrated.

3. Percent Differences - Abnormally high positive or negative percent differences for SO_2 probably indicate the constant temperature oven may need recalibration, SO_2 permeation tube is empty, or mass flow controller needs calibration.